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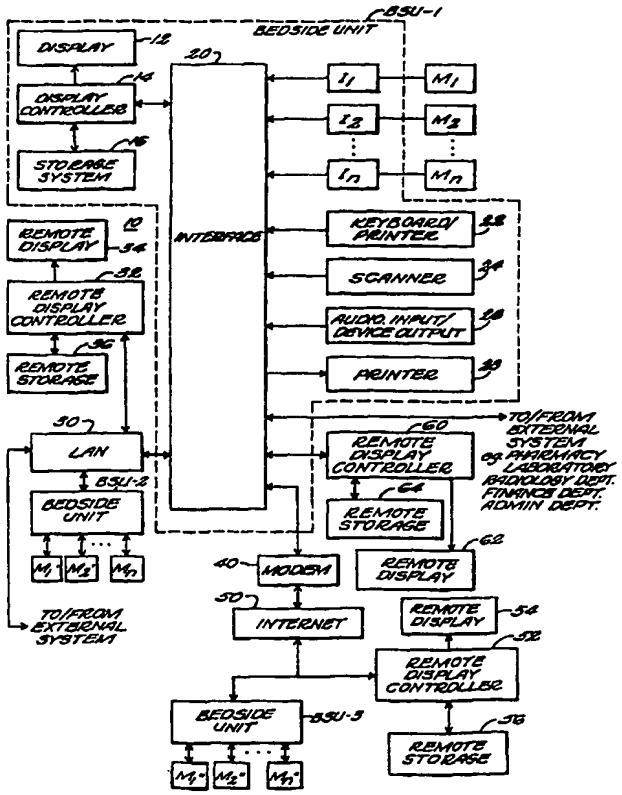
(54) Title: MEDICAL INFORMATION SYSTEM

(57) Abstract

A medical information system receives patient data and information from various sources and displays such information in a variety of formats for use by member of a medical team in a hospital, clinic, or office. The system receives patient information from doctors, pharmacists, patient monitoring equipment, testing laboratories, and/or computer databases. Access to selected subsets of patient information is provided by user selection of specific data sets identified by job function selection icons. A member of the medical team can record observations about a patient using key words and phrases which can be supplemented with additional text for customized notation. Multiple types of patient data are selectively displayed simultaneously, and to multiple remote users. The system can access stored data according to user–specified formulae to compute a score or metric which reflects a relationship between various factors, each factor being weighted appropriately according to its significance as defined in the formula. A user can selectively display data in graphic form by "clicking" on a row of tabular data in a tabular region of the display and "dragging and dropping" that row to a graphic display region of the display.



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MEDICAL INFORMATION SYSTEM

Field of the Invention

The present invention relates to computerized information systems, and more particularly to information systems which can receive patient data and information from various sources and can display such information in a variety of easily understood formats for use by members of a medical team in a hospital, clinic or office.

Background of the Invention

When an individual is admitted as a patient into a hospital, certain information about the patient must be acquired and made available to various members of the hospital staff. Such information includes, for example, the patient's identity, address, age and occupation, next of kin, medical history, conditions for which treatment is sought, preexisting conditions, and any medical insurance information.

During a patient's stay in a hospital, written information relating to his medical history, doctors' and nurses' observations and remarks, laboratory reports, diagnoses, doctors' orders, prescriptions and other notes by the medical team, including doctors, nurses, technicians, orderlies and the like, become part of the patient's file. Patients with chronic conditions or who are frequently hospitalized may have numerous files of substantial size which contain important historic, as well as current, information. The information that is necessary to provide a complete picture of the patient includes, for example, the patient's vital signs, fluid balance, respiratory function, blood parameters, electrocardiograms, x-rays, CT scans, MRI data, laboratory test results, diagnoses, prognoses, evaluations, admission and discharge notes, and patient registration information. This information originates from a variety of sources, including the patient, doctors, nurses, monitors connected to the patient, testing laboratories, the patient's medical records, and hospital administration records.

A massive amount of information about the patient is therefore generated in a relatively short time. Some or all of this information is typically manually recorded in a flowchart which is affixed to the patient's bed. A disadvantage of manual recordation of such information is that it is slow and tedious. Consequently, such information is susceptible to later

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misinterpretation because of illegibility, incompleteness, the sheer volume of information being recorded and tracked, and human error.

Although critical care environments, such as hospital intensive care units, trauma units, emergency rooms and the like, are filled with state-of-the-art electronic equipment for monitoring of patients, these devices still do not provide the medical team with a clear and complete picture of the patient and the efficiency of the treatment which he is receiving. Existing medical display systems are disadvantageous because they are incapable of interconnection with a variety of instruments and monitors, especially if such equipment is made by several different manufacturers. In addition, most existing systems save patient data for a relatively short time, often for less than the duration of a typical patient's stay in the hospital. Also, existing systems typically cannot accept the manual entry of information and/or cannot combine such information with data received from other electronic devices.

Much of the information contained in a patient's files may be absolutely essential for effective and timely treatment. Unfortunately, this essential information may not be easily retrievable from the volumes of information in a patient's records. The necessary information may be overlooked, or mistranscribed, or entered in an incorrect location on the chart. In other circumstances, because of the urgency associated with the patient's condition, the medical team may not have time to search through a patient's file for certain vital information.

In addition, a patient's treatment plan consists of a series of instructions that may change during the course of treatment. In a manually recorded and displayed system, such as a flowchart attached to a patient's bed, it is difficult to ensure that all details of a treatment plan are recorded, and it is difficult to track such manually recorded information. As a result, a patient may receive a treatment late, or not at all. Clearly, if the medical team cannot access essential information about a patient in a timely and complete manner, the quality and effectiveness of the care and treatment of the patient may be compromised.

Many hospitals have changed the way in which patients are billed for services. In the past, patients were typically billed on the basis of days hospitalized. With recent changes in health care management and practice, patients are now more likely to be billed on the basis of

treatments received. Greater efficiency in the treatment of patients is therefore emphasized. As a consequence, hospitals now scrutinize the effect of a treatment on a patient more closely, with increased monitoring, observation and recordation of the patient's responses to treatment. The increased amount of information that must be recorded about a patient makes the existing manual-entry system extremely cumbersome and time-consuming for the medical team.

There exists a need for all data and information obtained from and about a patient in a hospital to be immediately and selectively accessible to various members of the medical team in a hospital in accordance with the function performed by those members.

Objects of the Invention

An object of the present invention is to obviate the disadvantages of the prior art.

Another object of the present invention is to provide a medical information system which displays all types of medical information about a patient in a variety of easily understood formats.

Another object of the present invention is to provide a medical information system which receives patient information from a wide variety of sources, such as, for example, doctors, pharmacists, patient monitoring equipment, testing laboratories, and other computer databases.

Another object of the invention is to provide a medical information system in which access to selected subsets of patient information is gained by selection of specific data sets identified by "job function" selection icons.

Another object of the invention is to provide a medical information system which permits a member of the medical team to record observations about a patient using key words and phrases which can be supplemented with additional text for customized notation.

Another object of the invention is to provide a medical information system which presents multiple types of patient data simultaneously.

Another object of the invention is to provide a medical information system which can be accessed by more than one user and which permits simultaneous viewing of patient information by more than one user.

Another object of the invention is to provide a medical information system which can be updated in real time with additional patient information.

Another object of the invention is to provide a medical information system which permits graphical displays of multiple types of patient data using a common time scale.

Another object of the invention is to provide a medical information system which provides for score computation and identification of missing parameters or values necessary for successful computation.

Another object of the invention is to provide a medical information system which provides for active control of peripheral devices, such as respirators, infusion pumps, intravenous pumps, and the like.

Another object of the invention is to provide a medical information system which is capable of storing patient data for at least the period of the patient's current hospitalization, and preferably for much longer periods of time.

Another object of the invention is to provide a medical information system which is capable of recalling patient data from records created during previous hospital stays.

Summary of the Invention

These and other features of the invention will be more fully appreciated with reference to the following detailed description which is to be read in conjunction with the attached drawings.

Brief Description of the Drawings

The invention is further described by the following description and figures, in which:

FIG. 1 shows in block diagram form, a medical information system embodying the invention.

FIG. 2A shows an exemplary display screen, illustrating split-screen aspects of the invention;

FIG. 2B shows an exemplary display screen illustrating multiple image aspects of the invention.

FIG. 3A shows an exemplary "Physician" display screen; and

FIG. 3B shows an exemplary "Nurse" display screen.

Detailed Description of the Preferred Embodiment

A medical information system 10 of the present invention is shown in FIG. 1. The system 10 includes a primary display 12, and an associated display controller 14 and system storage device 16. The controller 14 is coupled to a primary interface nit 20. Keyboard and/or pointing device 22, scanner 24, audio input and/or output device 26 and printer 28 are all coupled by way of interface unit 20 to the display controller 14. In the preferred embodiment, these elements are established by a personal computer such as a Gateway 2000 Pentium Pro™ 200 Mhz system, programmed to perform the functions described in detail below.

A plurality of patient bedside monitors (such as a Hewlett-Packard Model M66 Merlin monitor) and other instruments (such as Puritan-Bennett Model 7200 ventilator), denoted M1, M2, . . .M_n in FIG. 1, are coupled by way of separate interface units, I1, I2, . . ., I_n respectively, to the display controller 14.

In the illustrated embodiment, the various units M1, M2, . . . M_n, and their associated interface units I1, I2, . . . I_n, as described in detail below. Together, elements 12, 14, 16, 20, I1, I2, . . ., I_n establish a bedside unit, denoted BSU-1 in FIG. 1.

In the present embodiment, the interface 20 also is coupled by way of a local area network (LAN) 30 to a remote display controller 32, which in turn is coupled to a remote display 34 and a remote storage 36. In other embodiments, the latter coupling may be effected by way of an interface similar to interface unit 20, which in turn may be coupled to various bedside monitors or other instruments.

The interface unit 20 is also coupled by way of modem 40 and the Internet 50 to another remote display controller 52, which in turn is coupled to a remote display 54 and remote storage 56. In a similar manner, this coupling may be effected by way of another interface similar to interface unit 20, which may also couple various bedside monitors and other instruments.

In addition, the interface unit 20 is also directly coupled to a remote display controller 60, which in turn is coupled to remote display 62 and remote storage 64.

A second bedside unit BSU-2 couples units M1, M2 and M_n, (which may be similar to elements M1", M2" and M_n") by way of LAN 30 to interface 20.

In BSU-1, the display 12 generates images in response to a set of display signals which are generated by display controller 14. The controller 14 is capable of receiving multiple data sets, each data set being representative of medical information. The controller 14 includes a user device (keyboard/pointer 22) which is responsive to a user selection action for generating a selection signal. The user device may be any kind of selection device, for example, a keyboard (with cursor control), mouse, light pen, trackball, touch pad, or voice controlled pointer provided by speech recognition software.

In the illustrated form of the invention, the selection signal represents one of several subsets of the medical information data sets. Each subset is associated with a user job function

or a user department. The number of possible subsets of the medical information data sets is greater than one. The controller 14 is also capable of generating display signals in response to the selection signal. The display signals represent the subset of medical information which is associated with the generated selection signal. The displayed image also corresponds to the subset associated with the generated selection signal.

By way of example, the user job functions are selected from the group consisting of doctor, nurse, pharmacist, administrator, insurance coordinator, quality controller, and assistants thereto. The departments are selected from the group consisting of medical, pharmacy, administration, finance, and insurance departments. In other forms of the invention, additional, or different sub-sets of, user job functions and departments may be incorporated.

The data sets include sets of information from the group consisting of patient identity and admission information, patient diagnosis information, patient measurement information, patient treatment plan information, patient order information, and patient treatment information. Additional, or different sub-sets of, data sets may alternatively be incorporated in other forms of the invention.

As described more fully below, BSU-1 collects data in real time from a variety of sources, including electronic monitoring equipment attached to the patient and in remote laboratories, as well as other input devices, such as a keyboard, by which a member of the medical team can record observations, notes, orders and the like. Each instrument is interconnected with the display system with a universal interface device for facilitating input and output of information, such as, for example, an RS-232 interface. In the present embodiment, BSU-1 includes a Windows®-type operating system which provides a user-friendly display screen with prompts for accessing and entering medical information.

The medical data and other information of interest to the medical team is stored in a personal computer (PC), which processes and displays the information in real time in a graphic and/or text display. Various reports can be generated from the stored data. The user can

combine different sets of data from different sources to obtain customized summaries of the patient's status and progress.

In use, a BSU is located near each patient bed in a hospital ward, such as in an intensive care unit (ICU). The BSU is coupled to each of the electronic monitoring devices attached to the patient, such as, for example, a respirator, blood pressure monitor, or an electrocardiograph (referred to as M1, M2, . . .M_n in FIG. 1). In other forms of the invention, active devices, such as infusion pumps can be coupled to the BSU. In addition, the BSU is connected via interface 20 to a distributed electronic database, which may be generated or maintained by or in conjunction with other departments within the hospital, such as, for example, imaging, hematology, pulmonary, pathology, and various laboratories. The BSU at the patient's bedside receives information continuously from each of the devices and is adapted to permit manual entry of information as well.

Remote data displays (such as displays 34, 52 and 62, or those in BSU-2 and BSU-3, in FIG. 1) are also located at doctors' offices and nurses' stations to permit the medical team to monitor and review patient information and to receive reminders of actions to be taken. Because all information that is generated is stored in a common database, the system permits simultaneous viewing of the information by multiple users.

The system provides for the entry and monitoring of action items, such as, for example, orders for drugs or other treatments. Operational reminders are then generated and transmitted to the medical team. The system further permits entry of confirmatory information by the appropriate member of the team to verify that an order has been carried out. Compliance with orders is tracked as well, and the display screen can indicate an alarm or other warning indicator which notifies the medical team that an order has not yet been carried out.

The system further has the capability of providing customized notations in a patient's file using predefined phrases which can be combined and edited as needed. The use of predefined terminology eliminates the use of highly specialized or confusing vernaculars in the description of a patient's condition.

The system can additionally perform computations relating to the severity of a patient's condition. The system can access stored data according to user-specified formulae to compute a "score" which reflects a relationship between various factors, each factor being weighted appropriately according to its significance as defined in the formula. The system permits the medical team to define and enter formulae for various conditions. In addition, the system indicates an inability to complete a computation if one or more parameters in a given formula is missing. The system indicates which parameters are missing and, if possible, computes a value for the missing parameter using available information.

Alternatively, all data in the system can be saved locally in each BSU in the network. Thus, at least two copies of the data are retained at all times.

In the illustrated embodiment, reliability is enhanced in the following names. Each BSU in a LAN continuously monitors the integrity of its link to a server. In the event of link failure, incoming data is stored locally at the BSU. Otherwise the data is transferred to a server, where it is mirrored to a backup store or another server in real time.

Use of the system in a hospital can effect a significant savings in the time spent by the medical team in reviewing and recording patient information.

The system includes various security provisions to ensure the integrity of the data as it enters the network, and further to ensure that only authorized persons are able to access the information, enter additional information and orders, and change data. For example, each operator's identity is recorded and associated with each action taken. Operator identity can be encoded, for example, with a multi-digit number or an alphanumeric code. Second, certain operations are restricted to certain members of the medical team: for example, only doctors are permitted to access and enter information relating to prescriptions for drugs and treatment therapies. Only pharmacists are permitted to access and enter information relating to the filling of prescriptions. Only nurses and other technicians are permitted to access and enter information relating to administration of drugs and treatments. Third, customized input masks are provided to ensure that the effects of errors or mistakes are not introduced into the system, such as by the entry of incorrect or incompatible information. For example, if a doctor enters

a value which is outside a permitted range, an out-of-range message appears, prompting the user to check the value. Such masks cannot be overridden by the medical team and therefore ensure the integrity of the information in the system.

Split Screen Drag and Drop Display

FIG. 2A shows an exemplary screen display showing Vital Signs data for a patient in both tabular and graphical forms. A user may use the graphics "button to select graphic-only, tabular-only, or graphic/tabular (as illustrated) form. When in the latter form, the user can selectively determine which data is graphed by "clicking" on a row of tabular data and "dragging and dropping" that row to the graphic display region, where that tabular data is then illustrated in graphic form on the then-effective time base for the screen. Similarly, to simplify or otherwise customize the graphic display, the user may "click" on one of the graphs and "drag and drop" that graph to the tabular region of the screen, removing that graph from the graphic display region of the screen. Preferably, the different graphs in the graphic display region are different colors, and are coordinated with the colors of the background for the respective legends for the data in the tabular region of the display.

Multiple Image Display

In general, the multiple image display aspect of the invention provides a multiple image medical information system. The display 12 is responsive to display signals for generating n medical data images in an image field, where n is an integer, and where each of the images is in an associated one of n regions of the image field of display 12. A multitasking display controller generates the display signals. That controller includes a data device, a user select device, and a display signal generator. The data device generates patient data representative of patient-related information, including m subsets of the patient data, where m is an integer greater than n. The user select device is responsive to user action to select k of the m subsets of patient data, where k is an integer greater than and less than or equal to n. The display signal generator responsive to the user select device for generating k of the display signals, each being representative of an associated one of the selected subsets of patient data and being associated with one of the regions of the image field. The resultant k medical data images correspond to the k selected subsets of patient data an are displayed on the display 10 in the respective associated regions of the image field. In one form, at least one of the m subsets of

patient data is representative of a plot of at least two measured patient characteristics as a function of a reference parameter on a common scale, where the reference parameter is time. Preferably, for one subset of patient data, the measured characteristics and the reference parameters are selectively determined by a user, and wherein the data of at least one of the m subsets of patient data corresponds to measured patient characteristics and associated reference parameter values. The measured patient characteristics may be from the set consisting of blood pressure and others, the associated reference parameters are from the set consisting of time and others.

A screen at display 12, illustrating the ability of the system to present multiple graphical displays of patient information, is shown in FIG. 2B. The menu bar shows icons MI1, MI2, MI3 and MI4 which respectively offer the user a choice of one, two, three or four simultaneous displays. FIG. 2B illustrates four graphical displays entitled VITAL SIGNS, RESPIRATION, HEMATOLOGY and BLOOD GASES. Other displays, such as, for example, FLUID BALANCE, FLUID INPUT and FLUID OUTPUT, or other flow chart parameters, can also be selected. As for the screen display described in conjunction with FIG. 2A, each of the data sets can be displayed in a variety of formats, including graphical, tabular, bar chart and pie chart formats, with or without split screen. As in FIG. 2A, "drag and drop" may be used to modify and/or customize the images. In FIG. 2B, the graph in the VITAL SIGNS display includes multiple traces which represent, respectively, DBP (diastolic blood pressure), SBP (systolic blood pressure) and CVP (heart rate). The table below the graph includes numerical data in one minute intervals of time. The time scale can be selectively changed by a user for any or all of the images.

The data is presented in a way which maximizes its utility and facilitates its interpretation by the medical team. Note that a display may contain more information than can be seen in a multiple-display window. Each display can be scrolled through independently to review all the information contained therein, or maximized to fill the entire display screen, by selecting the appropriate icons at the right side and bottom of each display.

Information is collected in real time. As a consequence, data collection may occur during the period in which a member of the medical team is reviewing a patient's data file. In

this instance, a message appears on the display screen to indicate that a particular data set is being updated.

Job Function Display Screen

According to the job function display aspect of the invention, the display 12 is responsive to display signals to generate an image which shows one selected view from a set of possible view of the data in a database at system 10. Preferably, the various possible views are each associated with a job function of a corresponding set of possible system users of system 10. For example, a doctor, by virtue of his or her job function, would generally have an interest in viewing a certain subset of a patient's data from BSU-1. Similarly, a nurse, by virtue of his or her job function, would generally have an interest in viewing a different subset of that same patient's data. FIG. 2A shows an exemplary screen having menu choices for each of a "Physician" and a "Nurse". While not shown in FIG. 2A, other job functions, or department's (such as pharmacy or lab) for whom displays might be desired, can also have menu selectors.

FIG. 3A is an exemplary screen following selection of "Physician" and FIG. 3B shows an exemplary screen following selection of "Nurse". The screens of FIGS 3A and 3B show different sets of patient data that may be useful for the Physician and Nurse job functions, respectively. With the invention, each of the data sets for the respective job functions may be custom selected by a user, but in general, because of the difference in needs for users with the different job functions, the displayed data sets will be different.

In operation, the display controller 14 generates the display signals for display 12 in the following manner. Controller 14 receives n sets of data, where n is an integer greater than 1, and where each data set is representative of medical information. A user device 15 responsive to a user action to selectively generate a selection signal representative of one of k subsets of the n data sets, where each of the subsets is associated with one of k user job functions or departments, where k is an integer greater than one. Controller 14 is responsive to the selection signal to generate display signals representative of the subset associated with the generated selection signal, so that the image corresponds to the subset associated with the generated selection signal. By way of example, the user job functions are selected from the

group consisting of physician (or doctor), nurse, pharmacist, administrator, insurance coordinator, quality controller, and assistants thereto, and the departments are selected from the group consisting of medical, pharmacy, administration, finance, insurance, epidemiology, human services, and statistical and academic studies departments. The respective ones of the n sets of data include sets representative of information from the group comprising patient identity and admission information, patient diagnosis information patient measurement information, patient treatment plan information, patient order information, patient treatment information.

The following examples illustrate a particular configuration, although many variants can be used within the scope of the invention. Where user job function is "doctor," the k subsets are selected from the group consisting of patient history, physical examination data, current drug data, problem data, orders, progress notes, and summary reports. Where the user job function is "nurse," the k subsets are selected from the group consisting of problem data, care plan, orders, and critical pathways. Where the user job function is pharmacist, the k subsets are selected from the group consisting of drug orders, drug interactions and drug reference data. Where the user job function is administrator, the k subsets are selected from the group consisting of hospitalization days, procedures, and medical staff data. Where the user job functions is insurance coordinator, the k subsets are selected from the group consisting of patient cost data, risk factor data and claim data. Where the user job function is quality controller, the k subsets are selected from the group consisting of procedure time data, staff performance data, and disease/hospitalization data. Where the user department is medical, the k subsets are selected from the group consisting of patient history, physical examination data, current drug data, problem data, orders, progress notes, and summary reports. Where the user department is pharmacy, the k subsets are selected from the group consisting of drug orders, drug interactions and drug reference data. Where the user department is administration, the k subsets are selected from the group consisting of hospitalization days, procedures, and medical staff data. Where the user department is finance, the k subsets are selected from the group consisting of patient cost data, procedure cost data, and staff cost data. When the user department is insurance, the k subsets are selected from the group consisting of patient cost data, procedure cost data, and staff cost data.

In one form of the invention, selection of one of the job function selectors invokes a security program which limits access to a user unless a valid job function related code is and/or personal information number (PIN) is entered. Further, or alternatively, the access control program may control the system to be interactive for one or more users in a first user set and to be read-only for one or more of the selected subsets for one or more users in a second user set. By way of example, the first user set may include only users having the job function of physicians, and the second user set may include only users having the job function of nurse.

Medical Text Display

The medical text display aspect of the invention permits a user to readily compose and store anecdotal information. This is effected by entering text in part via a keyboard or speech recognition device, with a user controlled selector which may be used to select one or more text macro's (or phrases) stored in system 10.

Generally, the display 12 is responsive to display signals for generating text in an image field in display 12. A display controller generates the display signals. That controller includes a memory, a user select device a user text entry device and a display signal generator. The memory includes store data representative of a plurality of discrete phrases, each of the phrases being a sequence of words, or abbreviations or symbols therefor, representative of a medical condition. The user select device is responsive to a user action to (a) display one or more of the plurality of discrete phrases, and (b) select a sequence of one or more of the said phrases and identify text entry points representative of desired positions of the phrases in the image field of display 12. The user text entry device is responsive to user action to selectively determine text to be deleted from the selected sequence of phrases and additional text to be displayed in the image field at desired positions in the image field in or between the selected phrases. The display signal generator is responsive to the select device and the text entry device for generating the display signals, where the display signals are representative of the selected phrases and the determined text at their respective desired positions in the image field. The user select device may be one a keyboard, lightpen, mouse, trackball, touchpad and speech recognition text generator.

Patient Treatment and Progress Monitor

The system 10 also effects planning of patient treatment and monitoring of patient progress. The display 12 is responsive to display signals to generate text in an image field, where that text is constructed to define a treatment plan for a patient. For this function, the system 10 uses display controller 14 and storage system 16. The storage system (or memory) 16 stores (i) problem data representative of one or more possible problems associatable with a patient, (ii) treatment goal data representative of one or more treatment goals associated with each of the possible problems, (iii) treatment plan data representative of one or more treatment plans associated with each of the possible problems, and (iv) patient data. The patient data is representative of the identity of the patient, one or more unresolved problems associated with the patient (where each of the unresolved problems corresponds to one or more of the possible problems) and zero, one, or more of the treatments associated with each of the unresolved problems. The display controller generates the display signals using a user screen entry device which is selectively responsive to user action to (i) generate a display signal representative of the identity of a patient for whom treatment and progress information is to be displayed, and (ii) generate a display signal representative of selected problem data corresponding to the unresolved problems for the patient, treatment goal data associated with the selected problem data for the patient, and treatment plan data associated with the selected problem data for the patient. In one form of the invention, the memory further includes stored cost data associate with the treatment plan data, where the cost data is representative of the cost of effecting said treatment plans. In this form, the user screen entry device is selectively responsive to user action to generate a display signal representative of the cost of the treatment plan associated with the selected problem data for the patient. The user screen entry device is responsive to user action to generate an order signal indicative of a treatment plan to be effected, and for selectively generating a display signal representative of the order signal.

Medical Order Display

The system 10 also provides a display of medical order information. That portion of the system 10 includes the display 12 storage system 16, display controller 14 and an order device. The display 12 is responsive to signals from controller 14 to generate a medical data image. The storage system 16 stores data representative of patient orders. The order device is responsive to user action to generate and store order data in the storage device, where the order data is representative of patient orders. That order data for a patient includes: (i) order

data representative of the identity of the prescriber of a prescription, (ii) i.d. data representative of the identification of said patient, (iii) drug data representative of a drug prescribed for a patient in accordance with the prescription, and administration data representative of prescribed dosage and administration times in accordance with the prescription. The display controller generates the display signals. That controller is selectively operative to generate the display signals wherein at least information representative of the i.d. data, the drug data, and the administration data is displayed on said display device. The controller is also selectively operative responsive to user action to generate and store in the storage system, action data representative of an action taken with respect to the patient and one of said prescriptions, where the action data for one of the prescriptions is representative: (a) the delivery of a drug to the patient, (b) the identify of the drug delivered to the patient, and (c) the does and time of the drug delivered to the patient. The controller further monitors the order data for one or more of the patients and detects when action data does not correspond correct fulfillment of the order data and in response thereto, generates a display signal representative of an alarm. In conjunction with the said alarm display signal, an additional alarm may be effected in the form of an audible alarm, a visual alarm or a data alarm. In some form of the invention, the order data further includes authentication data representative of a encrypted identifier uniquely associated with the prescription, and the user device requires a user to generate an access request associated with the authentification data for a selected one of the prescriptions. In this form of the invention, the display generator confirms that the access request corresponds to the authentification data for the prescription and upon such confirmation, enables the user device to modify the data for said patient, modification of the order data is prevented it he event such confirmation is not made.

Medical Information Calculator

The system 10 also provides an improved on-screen medical calculator which permits interactive control by a user to perform computations necessary for various medical treatments and/or decisions. The calculator function permits determination of values from data required by a BSU from various coupled monitors. Where a requested value being determined cannot initially be accomplished for data presently on hand, the system 10 generates a display so advising the user, and also provides a second level routine that permits computation, or user entry, of values for the "missing" data. The latter routine may be selectively performed to

generate the necessary intermediate values. In the event data is to present for the second level routine, a similar process may be performed for a third level routine, and so on. Thus, system 10 provides an "intelligent" computations facility.

In general, the calculator function is performed for a BSU with the display 12, display controller 14 and storage system 16. The display 12 is responsive to display signals to generate a medical data image. The display controller 14 generates those display signals. The controller includes storage for sorting (a) at least two primary level computer programs for selectively effecting the determination of an associated first level intermediate value fro a plurality of primary values in accordance with a predetermined relationship between the primary values, wherein at least one of the primary values is representative of a measured parameter of a patient, and (b) zero, one or more intermediate level computer programs for selectively effecting the determination of an associated second level intermediate value from at least one of the first level intermediate values and a primary value representative of a measured parameter of a patient in accordance with a predetermined relationship between the one of the first level intermediate values and the primary values. The controller also includes a first memory for storing the primary values other than those representative of measured patient parameters. The first memory includes data values representing the primary values other than those representative of measured patient parameters. A second memory stores the primary values representative of measures patient values and includes data values representative of fewer than all of the primary values representative of measured patient parameters. A user device is responsive to user actions to generate a request signal representative of a request to display a computed value, where the computed value correspond to a value defined by a combination of the predetermined relationship. A processor is responsive to the request signal to invoke one or more of the primary level programs and zero, one or more of the intermediate level programs to effect the computation of the computed value. The process is operative when all necessary primary values representative of a measured patient parameter are resident in the storage devices, for generating the display signal whereby the computed value is displayed on the display device. The processor also determines occasions when a primary value representative of one of the primary values representative of a measured patient parameter is not resident in the storage device. In response to such determination, the process is to generate a display signal whereby a prompt identifying the non-resident primary value is

displayed in the display device. The user can then determine and enter a value to be used for the non-resident value so that the desired calculation can be effected.

The invention may be embodied in other specific forms without departing from the spirit or essential characteristics thereof. The present embodiments are therefore to be considered in all respects as illustrative and not restrictive, the scope of the invention being indicated by the appended claims rather than by the foregoing description. All changes that come within the meaning and range of the equivalency of the claims are therefore intended to be embraced therein.

What is claimed is:

1. A multiple image medical information system, comprising:

A. a display device responsive to display signals for generating n medical data images in an image field, where n is an integer, each of said images being in an associated one of n regions of said image field,

B. a multitasking display controller for generating said display signals, including:

i. data device for generating patient data representative of patient-related information, said patient data including m subsets of said patient data, where m is an integer greater than n,

ii. user select device responsive to user action to select k of said m subsets of said patient data, where k is an integer greater than and less than or equal to n,

iii. display signal generator responsive to said user select device for generating k of said display signals, each of said k display signals being representative of an associated one of said selected subsets of patient data and being associated with one of said regions of said image field,

whereby said k medical data images corresponding to said k selected subsets of said patient data are displayed on said display devices in the respective associated regions of said image field.

2. A system according to claim 1 wherein at least one of the m subsets of patient data is representative of a plot of at least two measured patient characteristics as a function of a reference parameter on a common scale.

3. A system according to claim 2 wherein said reference parameter is time.

4. A system according to claim 1 wherein for said one subset of patient data said measured characteristics and said reference parameters are selectively determined by a user.

5. A system according to claim 1 wherein the data of at least one of said m subsets of patient data corresponds to measured patient characteristics and associated reference parameter values.

6. A system according to claim 1 wherein said measured patient characteristics are from the set consisting of blood pressure and others and said associated reference parameters are from the set consisting of time and others.

7. A medical information system, comprising:

A. a display device responsive to display signals for generating an image,

B. a display controller for generating said display signals, including:

i. means for receiving n sets of data, where n is an integer greater than 1, each data set being representative of medical information,

ii. user device responsive to a user action to selectively generate a selection signal representative of one of k subsets of said n data sets, each of said subsets being associated with one of k user job functions or departments, where k is an integer greater than one,

iii. means responsive to said selection signal for generating display signals representative of the subset associated with said generated selection signal,

whereby said image corresponds to said the subset associated with said generated selection signal.

8. The system according to claim 7 wherein said user job functions are selected from the group consisting of doctor, nurse, pharmacist, administrator, insurance coordinator, quality controller, and assistants thereto.

9. The system according to claim 7 wherein said departments are selected from the group consisting of medical, pharmacy, administration, finance, insurance, epidemiology, human services, and statistical and academic studies departments.

10. The system according to claim 8 wherein the respective ones of said n sets of data include sets representative of information from the group comprising patient identity and admission information, patient diagnosis information, patient measurement information, patient treatment plan information, patient order information, patient treatment information

11. The system according to claim 10 wherein one of said user job functions is doctor and said k subsets are selected from the group consisting of patient history, physical examination data, current drug data, problem data, orders, progress notes, and summary reports.

12. The system according to claim 10 wherein one of said user job functions is nurse and said k subsets are selected from the group consisting of problem data, care plan, orders, and critical pathways.

13. The system according to claim 10 wherein one of said user job functions is pharmacist and said k subsets are selected from the group consisting of drug orders, drug interactions and drug reference data.

14. The system according to claim 10 wherein one of said user job functions is administrator and said k subsets are selected from the group consisting of hospitalization days, procedures, and medical staff data.

15. The system according to claim 10 wherein one of said user job functions is insurance coordinator and said k subsets are selected from the group consisting of patient cost data, risk factor data and claim data.

16. The system according to claim 10 wherein one of said user job functions is quality controller and said k subsets are selected from the group consisting of procedure time data, staff performance data, and disease/hospitalization data.

17. The system according to claim 10 wherein one of said user department is medical and said k subsets are selected from the group consisting of patient history, physical

examination data, current drug data, problem data, orders, progress notes, and summary reports.

18. The system according to claim 10 wherein one of said user department is pharmacy and said k subsets are selected from the group consisting of drug orders, drug interactions and drug reference data.

19. The system according to claim 10 wherein one of said user department is administration and said k subsets are selected from the group consisting of hospitalization days, procedures, and medical staff data.

20. The system according to claim 10 wherein one of said user department is finance and said k subsets are selected from the group consisting of patient cost data, procedure cost data, and staff cost data.

21. The system according to claim 10 wherein one of said user department is insurance and said k subsets are selected from the group consisting of patient cost data, risk factor data and claim data.

22. The system according to claim 7 wherein said display controller is a programmed digital computer.

23. The system according to claim 22 wherein said computer having a window-based operating system displaying icons representative of the respective ones of said job functions and departments, and said user device is a pointing device operatively connected to said computer by way of said operating system.

24. The system according to claim 23 wherein said pointing device is selected from the group consisting of keyboard, light pen, mouse, trackball, touchpad, voice controlled pointer.

25. The system according to claim 7 wherein said controller includes access means for selectively controlling operability of said user device by users.

26. The system according to claim 19 wherein said access means includes means to control said user device to be interactive for one or more users in a first user set and to be read-only for one or more of said selected subsets for one or more users in a second user set.

27. The system according to claim 20 wherein said first user set includes users having the job function of physicians.

28. The system according to claim 20 wherein said second user set includes user having the job function of nurse.

29. A medical information system, comprising:

A. a display device responsive to display signals for generating text in an image field,

B. a display controller for generating said display signals, including:

i. memory including stored data representative of a plurality of discrete phrases, each of said phrases being a sequence of words, or abbreviations or symbols therefor, representative of a medical condition,

ii. user select device responsive a user action to:

a. display one or more of said plurality of discrete phrases,

b. select a sequence of one or more of said phrases and identify text entry points representative of desired positions of said phrases in said image field,

iii. user text entry device responsive to user action to selectively determine text to be deleted from said selected sequence of phrases and additional text to be displayed in said image field at desired positions in said image field in or between said selected phrases,

iv. display signal generator responsive to said select device and said text entry device for generating said display signals, said display signals being representative of said selected phrases and said determined text at their respective desired positions in said image field.

30. A system according to claim 29 wherein said user select device is selected from the group consisting of keyboard, lightpen, mouse, trackball, touchpad and speech recognition text generator.

31. A system according to claim 29 wherein said user text entry device includes one from the group consisting of a keyboard and a microphone.

32. A patent treatment and progress monitor system comprising:

A. a display device responsive to display signals for generating text in an image field,

B. a memory including stored:

i. problem data representative of one or more possible problems associatable with a patient,

ii. treatment goal data representative of one or more treatment goals associated with each of said possible problems,

iii. treatment plan data representative of one or more treatment plans associated with each of said possible problems, and

iv. patient data representative of

a. said patient,

b. one or more unresolved problems associated with said patient, each of said unresolved problems corresponding to one or more of said possible problems, and

c. zero, one, or more of said treatments associated with each of said unresolved problems,

C. a display controller for generating said display signals, said display controller including a user screen entry device selectively responsive to user action to:

i. generate a display signal representative of the identity of a patient for whom treatment and progress information is to be displayed, and

ii. generate a display signal representative of:

a. selected problem data corresponding to said unresolved problems for said patient,

b. treatment goal data associated with said selected problem data for said patient, and

c. treatment plan data associated with said selected problem data for said patient

33. A system according to claim 32, wherein said memory further includes stored cost data associated with said treatment plan data, said cost data being representative of the cost of effecting said treatment plans, and

wherein said user screen entry device is selectively responsive to user action to generate a display signal representative of the cost of said treatment plan associated with said selected problem data for said patient.

34. A system according to claim 32 wherein said user screen entry device is responsive to user action to generate an order signal indicative of a treatment plan to be effected.

35. A system according to claim 34 further comprising means for selectively generating a display signal representative of said order signal.

36. A system according to claim 33, wherein said memory further includes stored cost data associated with said treatment plan data, said cost data being representative of the cost of effecting said treatment plans, and

wherein said user screen entry device is selectively responsive to user action to generate a display signal representative of the cost of said treatment plan associated with said selected problem data for said patient.

37. A medical order information display system, comprising:

A. a display device responsive to signals to generate a medical data image;

B. storage device for storing data representative of patient orders,

C. order device responsive to user action to generate and store order data in said storage device, said order data being representative of patient orders, said order data for a patient including:

i. order data representative of the identity of the prescriber of a prescription,

ii. i.d. data representative of the identification of said patient,

iii. drug data representative of a drug prescribed for a patient in accordance with the prescription, and

iv. administration data representative of prescribed dosage and administration times in accordance with said prescription,

D. a display controller for generating said display signals, including:

i. selectively operative means for generating said display signals wherein at least information representative of said i.d. data, said drug data, and said administration data is displayed on said display device,

ii. selectively operative administrator device responsive to user action to generate and store in said storage device, action data representative of an action taken with respect to said patient and one of said prescriptions, said action data for one of said prescriptions being representative:

a. the delivery of a drug to said patient

b. the identity of said drug delivered to said patient, and

c. the dose and time of said drug delivered to said patient,

iii. monitor means for monitoring said order data for one or more of said patients and for detecting when action data does not correspond correct fulfillment of said order data and in responsive to thereto, generating a display signal representative of an alarm.

38. The system according to claim 37 wherein said monitor means generates in conjunction with said alarm display signal, an additional alarm from the group consisting of audible alarm, visual alarm and data alarm.

39. A system according to claim 37 wherein said order data further includes: authentication data representative of a encrypted identifier uniquely associated with said prescription, and

wherein said user device further includes means for generating by a user an access request associated with said authentification data for a selected one of said prescriptions, and

wherein said display generator includes means for confirming that said access request corresponds to said authentification data for said prescription and upon such confirmation, enabling said user device to modify said data for said patient and for preventing modification of said order data otherwise.

40. A medical information calculator display system, comprising:

A. a display device responsive to display signals to generate a medical data image,

B. a display controller for generating said display signals, including:

i. storage device for storing:

a. at least two primary level computer programs for selectively effecting the determination of an associated first level intermediate value from a plurality of primary values in accordance with a predetermined relationship between said primary values, wherein at least one of said

primary values is representative of a measured parameter of a patient,

b. zero, one or more intermediate level computer programs for selectively effecting the determination of an associated second level intermediate value from at least one of said first level intermediate values and a primary value representative of a measured parameter of a patient, in accordance with a predetermined relationship between said one of said first level intermediate values and said primary values,

ii. first memory means for storing said primary values other than those representative of measured patient parameters, said first memory means including data values representing said primary values other than those representative of measured patient parameters,

iii. second memory means for storing said primary values representative of measured patient values, said second memory means including data values representative of fewer than all of said primary values representative of measured patient parameters,

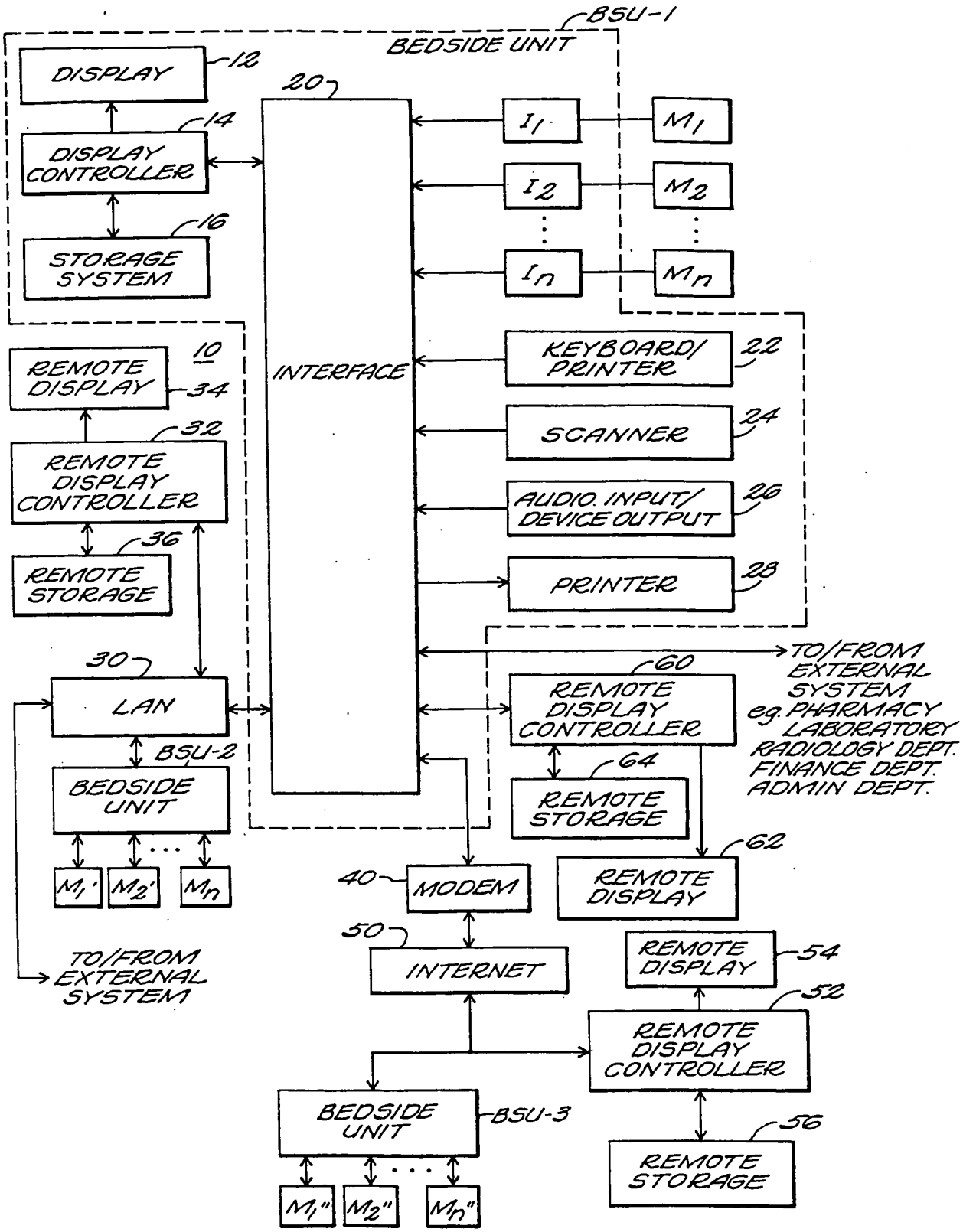
iv. user device responsive to user actions to generate a request signal representative of a request to display a computed value, said computed value corresponding to a value defined by a combination of said predetermined relationships;

v. processor means responsive to said request signal to invoke one or more of said primary level programs and zero, one or more of said intermediate level programs to effect the computation of said computed value, and further including:

a. means operative when all necessary primary values representative of a measured patient parameter are

resident in said storage devices, for generating said display signal whereby said computed value is displayed on said display device, and

b. means for determining occasions when a primary value representative of one of said primary values representative of a measured patient parameter is not resident in said storage device, and in response to such determination, operative for generating a display signal whereby a prompt identifying said non-resident primary value is displayed in said display device.


BSU-1
BEDSIDE UNIT
DISPLAY
12
20
DISPLAY CONTROLLER
14
STORAGE SYSTEM
16
I1
I2
In
M1
M2
Mn
REMOTE DISPLAY
10
34
INTERFACE
KEYBOARD/ PRINTER
22
SCANNER
24
AUDIO INPUT/ DEVICE OUTPUT
26
PRINTER
28
REMOTE DISPLAY CONTROLLER
32
REMOTE STORAGE
36
30
LAN
BSU-2
BEDSIDE UNIT
M1'
M2'
Mn
TO/FROM EXTERNAL SYSTEM
60
REMOTE DISPLAY CONTROLLER
64
REMOTE STORAGE
TO/FROM EXTERNAL SYSTEM
eg. PHARMACY
LABORATORY
RADIOLOGY DEPT.
FINANCE DEPT.
ADMIN DEPT.
62
REMOTE DISPLAY
40
MODEM
50
INTERNET
REMOTE DISPLAY
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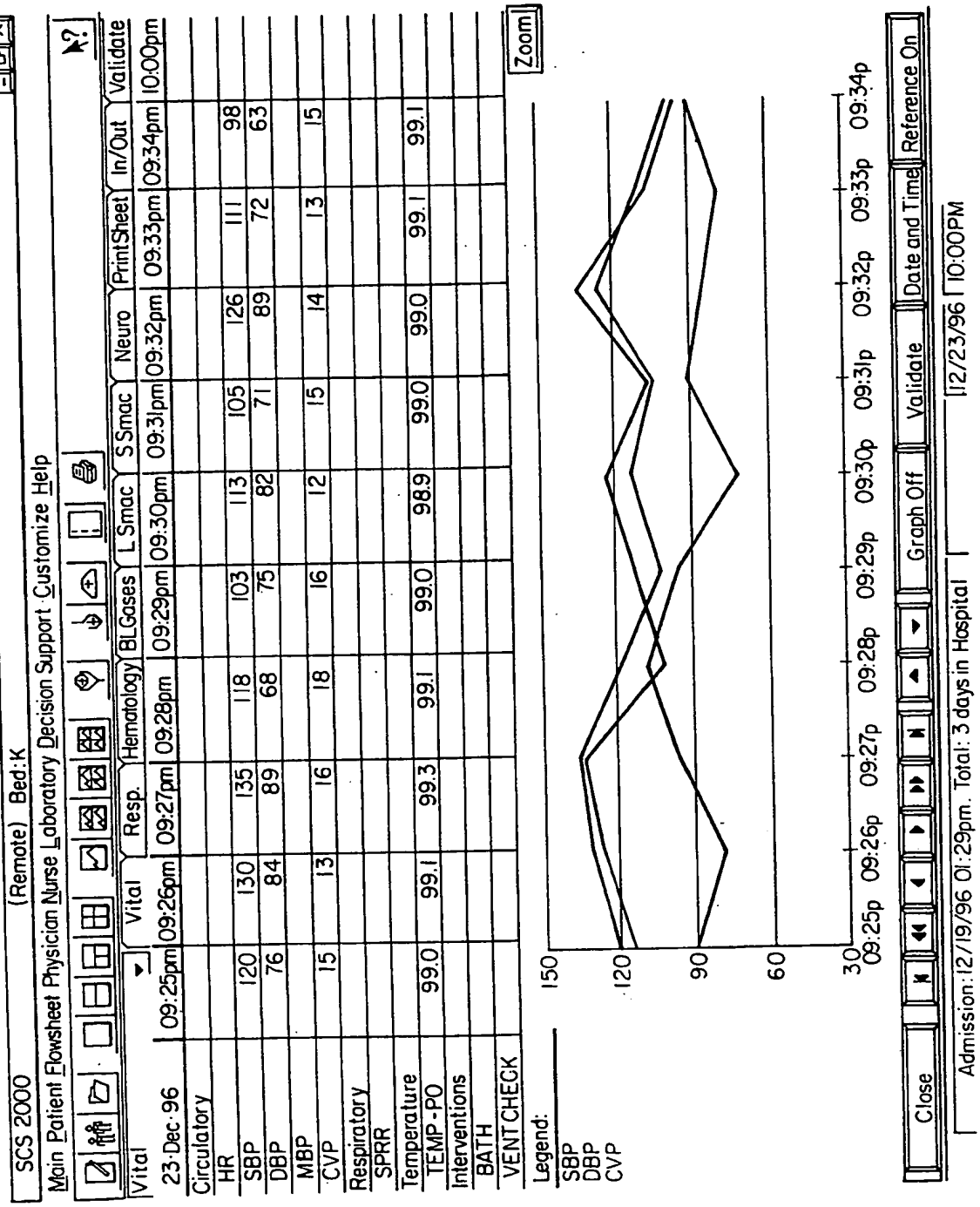
M1"
M2"
Mn"
56
REMOTE STORAGE

FIG. 1


SCS 2000
(Remote) Bed:K
Main Patient Flowsheet Physician Nurse Laboratory Decision Support Customize Help
Vital
Resp.
Hematology
BLGases
L Smac
S Smac
Neuro
PrintSheet
In/Out
Validate
23-Dec-96
09:25pm
09:26pm
09:27pm
09:28pm
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09:32pm
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09:34pm
10:00pm
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SBP 76 84 89 68 75 82 71 89 72 63
DBP
MBP
CVP 15 13 16 18 16 12 15 14 13 15
Respiratory
SPRR
Temperature
TEMP-PO 99.0 99.1 99.3 99.1 99.0 98.9 99.0 99.0 99.1 99.1
Interventions
BATH
VENTCHECK
Zoom
Legend:
SBP
DBP
CVP
150
120
90
60
30
09:25p 09:26p 09:27p 09:28p 09:29p 09:30p 09:31p 09:32p 09:33p 09:34p
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Date and Time
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12/23/96 10:00PM

FIG. 2A

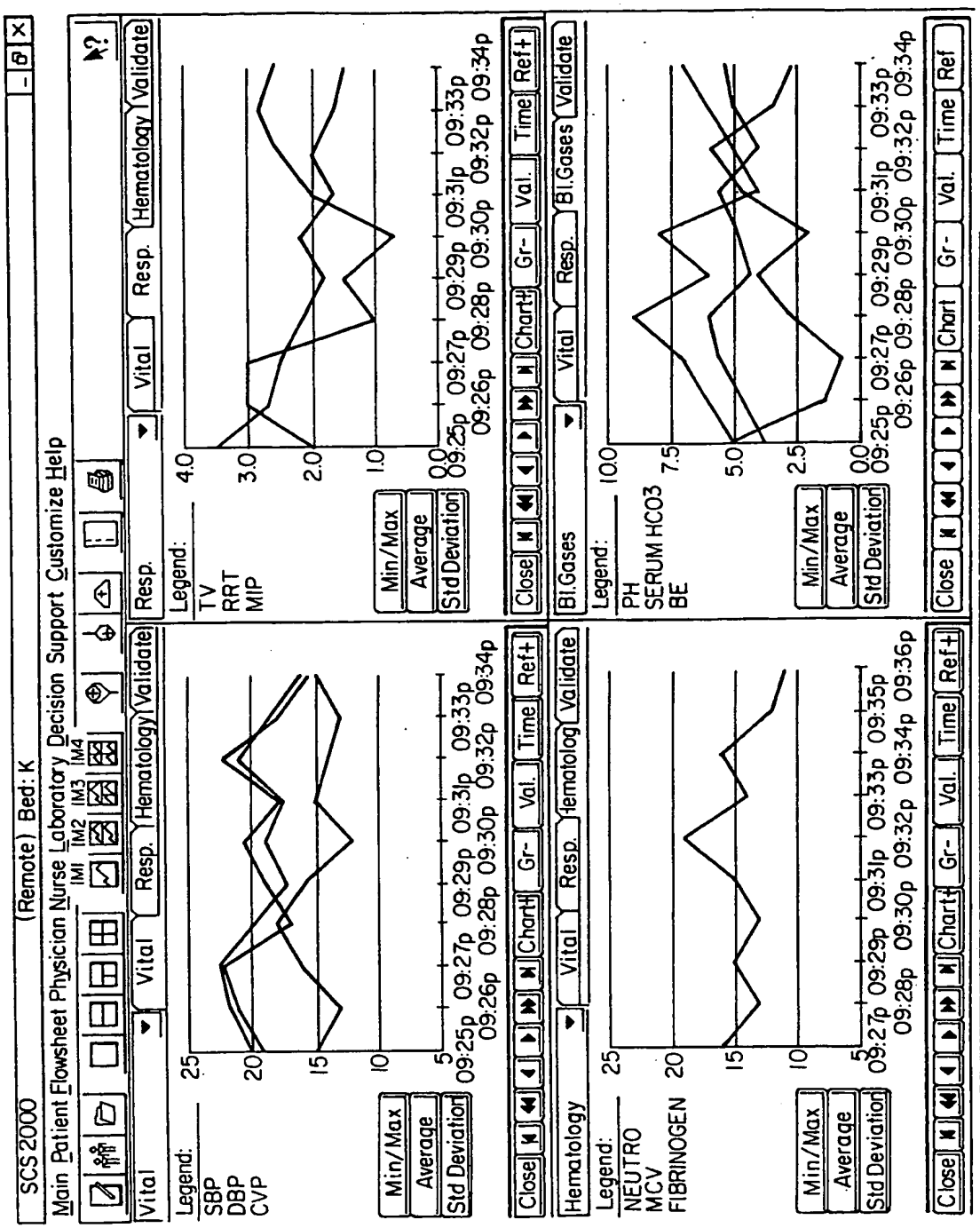
SCS 2000 (Remote) Bed: K
Main Patient Flowsheet Physician Nurse Laboratory Decision Support Customize Help
IM1 IM2 IM3 IM4
Vital Resp. Hematology Validate
Legend: SBP DBP CVP
Min/Max Average Std Deviation
Close Chart Gr- Val. Time Ref+
Resp. Vital Resp. Hematology Validate
Legend: TV RRT MIP
Hematology Vital Resp. Hematolog Validate
Legend: NEUTRO MCV FIBRINOGEN
Bl.Gases Vital Resp. Bl.Gases Validate
Legend: PH SERUM HCO3 BE
09:25p 09:26p 09:27p 09:28p 09:29p 09:30p 09:31p 09:32p 09:33p 09:34p 09:35p 09:36p
Admission:12/19/96 01:29pm, Total 3 days in Hospital
12/23/96 9:52PM

FIG. 2B

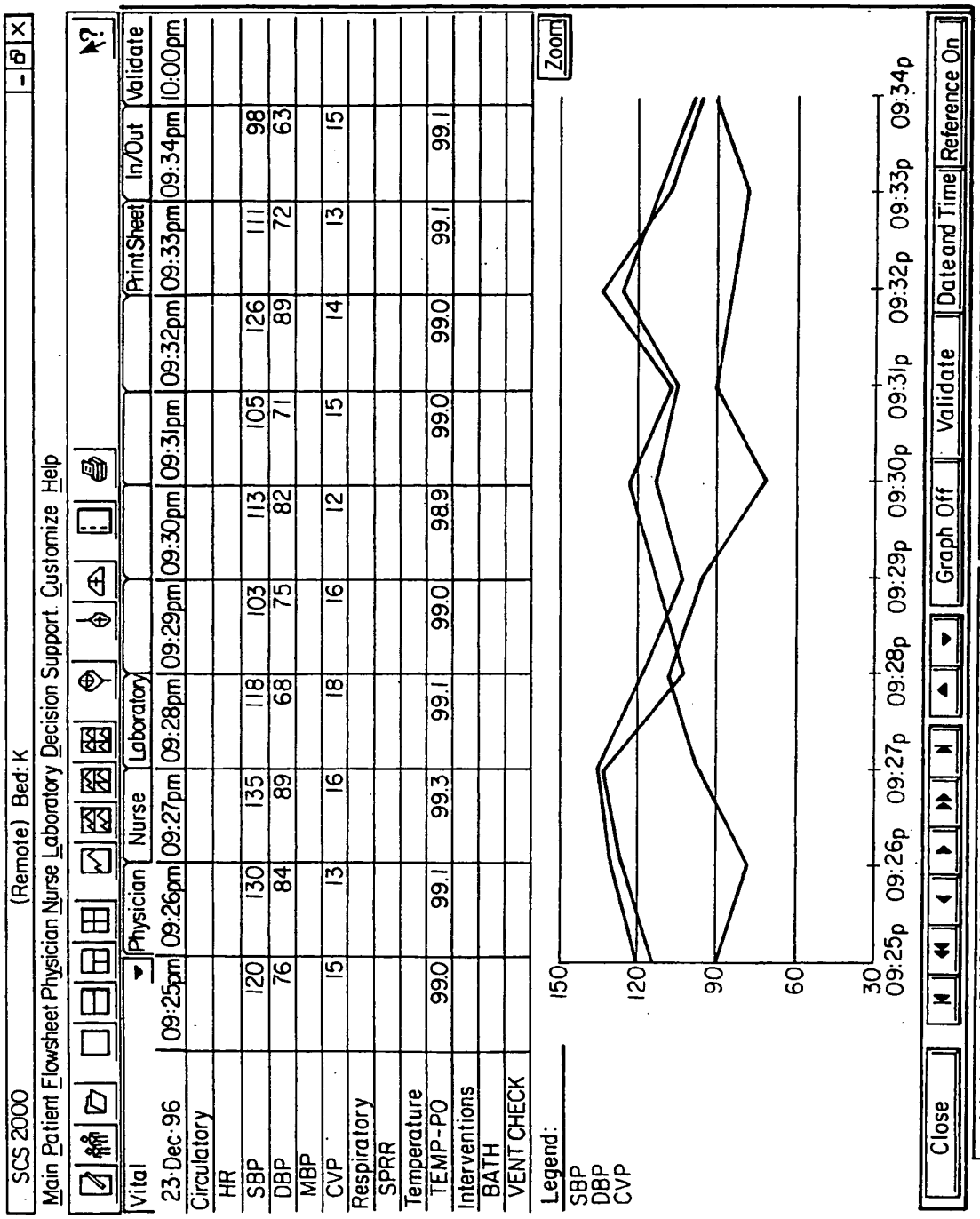
SCS 2000 (Remote) Bed: K
Main Patient Flowsheet Physician Nurse Laboratory Decision Support Customize Help
Vital
Physician
Nurse
Laboratory
Print Sheet
In/Out
Validate
23-Dec-96
09:25pm
09:26pm
09:27pm
09:28pm
09:29pm
09:30pm
09:31pm
09:32pm
09:33pm
09:34pm
10:00pm
Circulatory
HR
SBP 120 130 135 118 103 113 105 126 111 98
DBP 76 84 89 68 75 82 71 89 72 63
MBP
CVP 15 13 16 18 16 12 15 14 13 15
Respiratory
SPRR
Temperature
TEMP-PO 99.0 99.1 99.3 99.1 99.0 98.9 99.0 99.0 99.1 99.1
Interventions
BATH
VENT CHECK
Zoom
Legend:
SBP
DBP
CVP
150
120
90
60
30
09:25p 09:26p 09:27p 09:28p 09:29p 09:30p 09:31p 09:32p 09:33p 09:34p
Close
Graph Off
Validate
Date and Time
Reference On
Admission: 12/19/96 01:29pm Total: 3 days in Hospital
12/23/96 10:00 PM

FIG. 3A

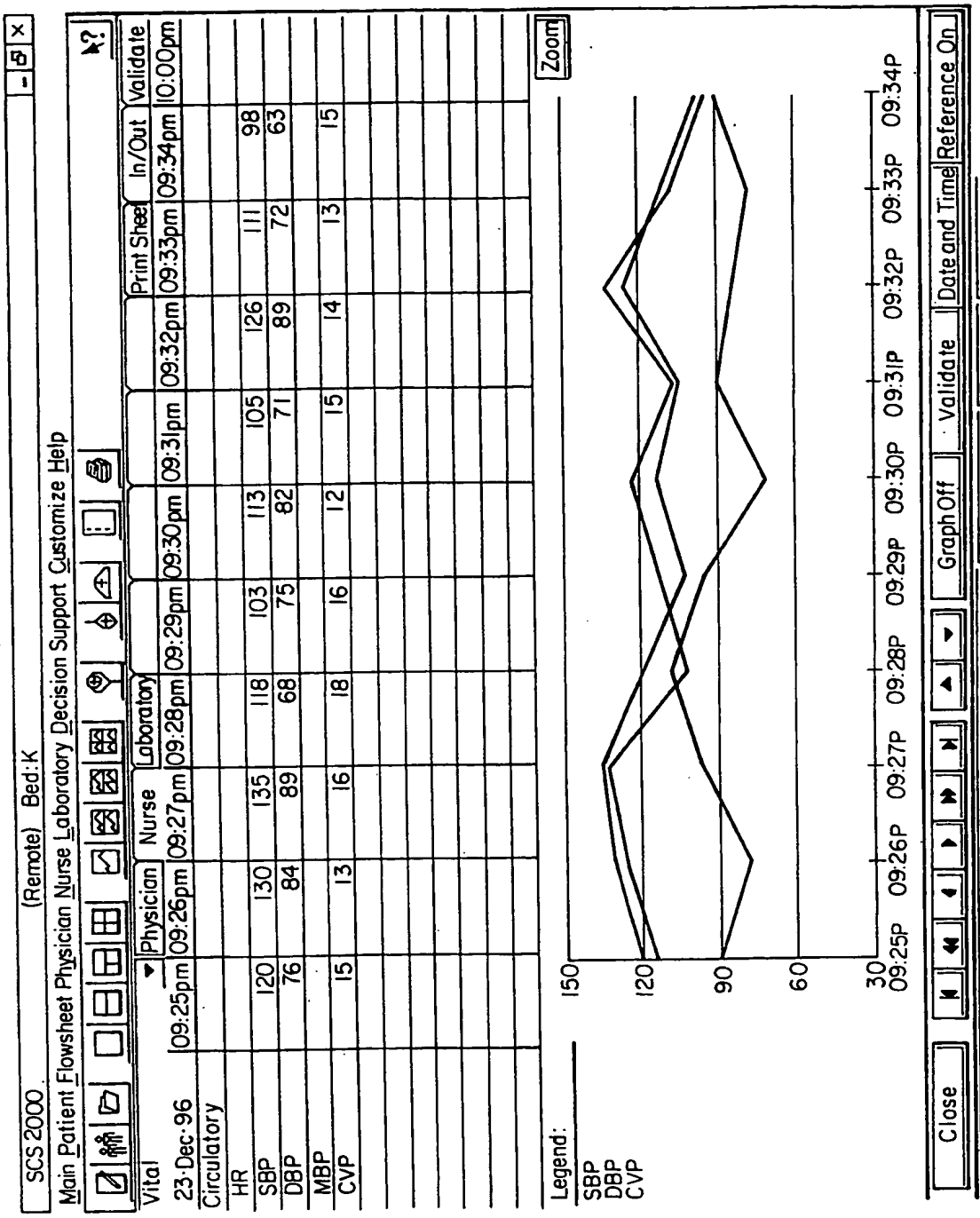
SCS 2000 (Remote) Bed:K
Main Patient Flowsheet Physician Nurse Laboratory Decision Support Customize Help
Vital
Physician
Nurse
Laboratory
Print Sheet
In/Out
Validate
23-Dec-96
09:25pm
09:26pm
09:27pm
09:28pm
09:29pm
09:30pm
09:31pm
09:32pm
09:33pm
09:34pm
10:00pm
Circulatory
HR
SBP 120 130 135 118 103 113 105 126 111 98
DBP 76 84 89 68 75 82 71 89 72 63
MBP
CVP 15 13 16 18 16 12 15 14 13 15
Zoom
Legend:
SBP
DBP
CVP
150
120
90
60
30
09:25P 09:26P 09:27P 09:28P 09:29P 09:30P 09:31P 09:32P 09:33P 09:34P
Close
Graph Off
Validate
Date and Time
Reference On
Admission: 12/19/96 01:29pm, Total: 3 days in Hospital
12/23/96 10:00PM

FIG. 3B

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